ePHENIX GEANT simulation tasks

Based on discussions during ePHENIX LoI preparation and presentations afterwards

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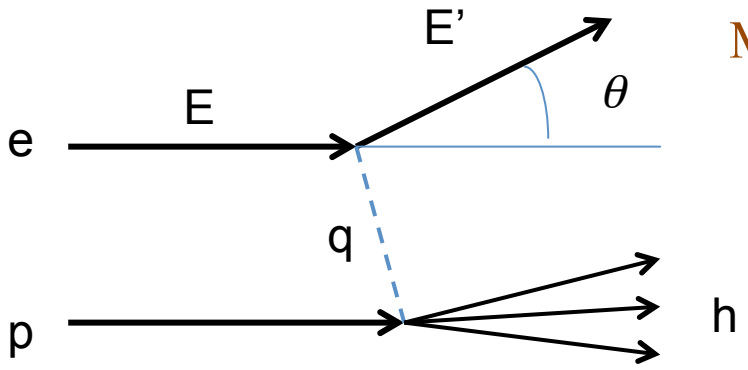
Inclusive DIS and DIS kinematics

Quark and gluon (helicity) distributions



Measure scattered electron energy E' and angle θ:

$$Q^2 = 4EE'\sin^2\left(\frac{\theta}{2}\right) \qquad y = 1 - \frac{E'}{E}\cos^2\left(\frac{\theta}{2}\right) \qquad x = \frac{Q^2}{sy}$$

Affecting the the final state electron (E', θ):

- ✓ Bremsstrahlung (photon radiation in material)
- ✓ QED Radiative effects (radiation of real or virtual photon)

Affecting the measured electron E', θ

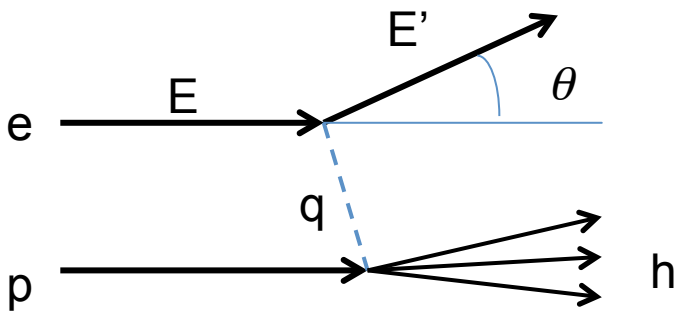
- ✓ Electron ID and purity: Background from hadrons and photon conversion in material ($\gamma \rightarrow e^+e^-$)
- ✓ Detector resolutions

Some of these absolutely need **GEANT MC**:

- ✓ Bremsstrahlung
- ✓ Photon conversion
- ✓ EMCal&HCal response to different particles
- ✓ Tracking

Eventually all these should be included in smearing matrix calculation to **unfold** (Q^2,x)

Jacquet-Blondel for kinematics reco



Another way to reconstruct DIS kinematics

- More precise at low y
- The only one for CC reactions (through W exchange)

Electron

$$Q^2 = 4EE'\sin^2\left(\frac{\theta}{2}\right)$$

$$y = 1 - \frac{E'}{E}\cos^2\left(\frac{\theta}{2}\right)$$

$$x = \frac{Q^2}{sy}$$

JB

$$Q^2_{JB} = \frac{p^2_{T,h}}{1 - y_{JB}} \qquad p^2_{T,h} = \left(\sum_h p_{x,h}\right)^2 + \left(\sum_h p_{y,h}\right)^2$$

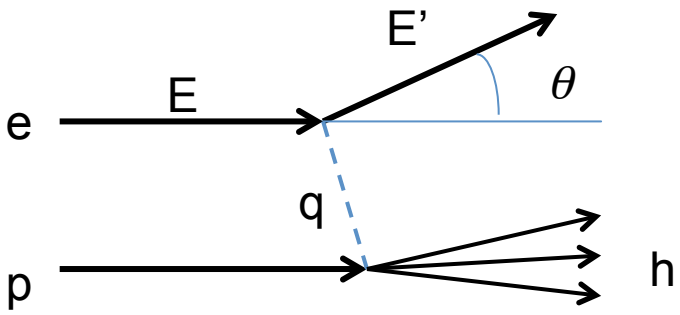
$$y_{JB} = \frac{(E - p_z)_h}{2E_e} \qquad (E - p_z)_h = \sum_h (E_h - p_{z,h})$$

$$x_{JB} = \frac{Q^2_{JB}}{sy_{JB}}$$

- ✓ Need to identify and reconstruct "all" hadrons
- ✓ Need to study how it is affected by the limitations in detector (tracking and PID) acceptances and efficiencies
- ✓ Backgrounds (including ghost tracks)

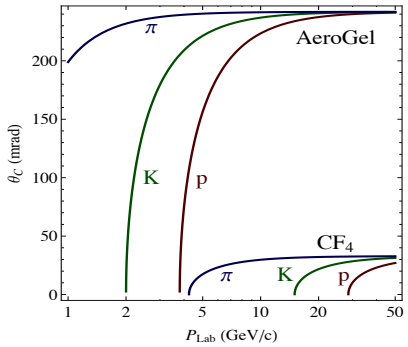
Semi-inclusive DIS

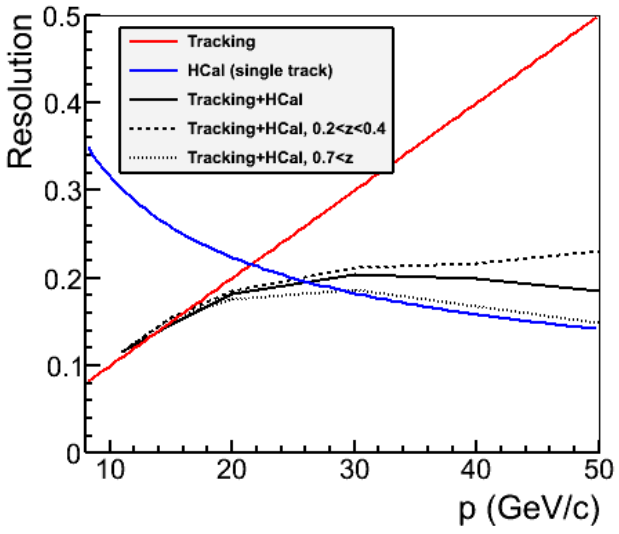
(Sea) quark helicity, TMD, hadronization



In addition to scattered electron, one or more of the final state hadrons is reconstructed

PID detectors (Gas RICH, Aerogel, DIRC) and tracking





Gas RICH performance at high p is limited by tracking resolution

HCal resolution for single hadron at high p and high rapidity is better than that of tracking, but it can not distinguish nearby tracks:

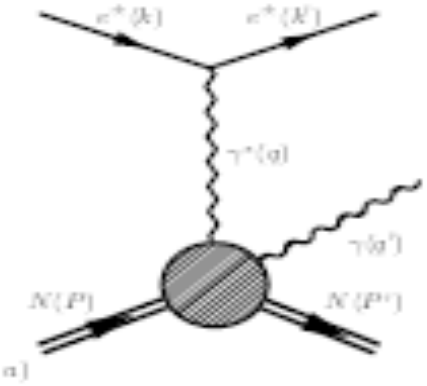
GEANT: how the combination of tracking and HCal may improve our measurements

GEANT: RICH and tracking performance, particularly at high rapidity

Also di-hadron and di-jets measurements, and D meson measurements

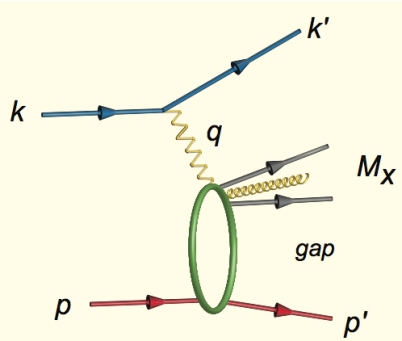
Exclusive and diffractive reactions

Proton tomography, Saturation



DVCS photon, J/psi, phi, rho, etc.

GEANT: Backgrounds, efficiencies (e.g. Bremsstrahlung and photon conversion in material for DVCS)



Rapidity gap method for diffractive

GEANT: how far HCal acceptance should go and effect of material (showering in it), which may contaminate high rapidity region, hence limit the high rapidity acceptance of HCal

There could be other directions for simulation:

- ✓ Aerogel: it is still the weakest point in our design, may need more thinking and (simulation) studies
- ✓ DIRC: worth taking a look
- ✓ Beamline detectors (Roman Pots, ZDC): being studied by BNL-EIC group
- ✓ Vertex tracker: not yet included in the current ePHENIX design
- ✓ ToF: not yet considered in the current ePHENIX design, need more studies

The suggested studies will not only serve to quantify the performance of the suggested detector system but also to develop/modify the detector design.